

**FINAL REPORT ON ELECTRONICS RESEARCH
AT THE UNIVERSITY OF TEXAS AT AUSTIN**

NO. 58

For the period August 1, 1995 through August 31, 1998

JOINT SERVICES ELECTRONICS PROGRAM

Research Contract AFOSR F49620-95-C-0045



November 30, 1998

ELECTRONICS RESEARCH CENTER

**Bureau of Engineering Research
The University of Texas at Austin
Austin, Texas 78712-1084**

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13. ABSTRACT (Maximum 200 words) This report summarizes scientific progress on "Basic Research in Electronics" which has been conducted under the auspices of the DoD Joint Services Electronics Program during the period 1 August 1995 - 31 August 1998. Progress on five solid-state, two information electronics, and one electromagnetic project is described.					
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JOINT SERVICES ELECTRONICS PROGRAM

Research Contract AFOSR F49620-95-C-0045

**Submitted by Edward J. Powers
on behalf of the Faculty and Staff
of the Electronics Research Center**

November 30, 1998

ELECTRONICS RESEARCH CENTER

**Bureau of Engineering Research
The University of Texas at Austin
Austin, Texas 78712-1084**

FINAL REPORT: JOINT SERVICES ELECTRONICS PROGRAM
CONTRACT AFOSR F49620-95-0045
The University of Texas at Austin

Research carried out under the auspices of this contract consisted of five research units in Solid State Electronics, one in Electromagnetics, and two in Information Electronics.

The objective of the Solid State Electronics program is to develop new materials and devices for electronic and photonic applications, based on an enhanced underlying knowledge of those materials and devices. To accomplish this task, a group of five faculty was assembled representing basic materials studies, transport and device theory and simulation, multilayer heterostructure growth, and device fabrication. The research is a coherent, cooperative program, with considerable synergy among the investigators. The MBE growth of multilayer heterostructures is used in the development of vertical cavity surface-emitting lasers (VCSEL), and in building novel microcavity photodetectors. Underlying all of these materials and device studies are theory and simulation contributions and femtosecond optical probes. Because of the progression from materials to devices provided by this research team, the research benefits from immediate feedback from measurements and device studies of the heterostructures under development.

A new understanding of MBE growth was achieved, and this understanding was applied to growth of high-quality multilayer heterostructures. Recent progress relating to VCSEL's involved three areas related to optical emitters and devices based on Fabry-Perot microcavities. These are further development of the theoretical modeling, development of a new form of dielectrically appertured VCSEL, and finally an initial investigation of the cavity effect on controlled spontaneous lifetime. New photodetectors have been designed, fabricated, and characterized to achieve enhanced performance relative to conventional photodetectors. Development and characterization of models and tools for the study of charge transport in semiconductors on ultra-short spatial and temporal scales were carried out. Advances in femtosecond laser technology were used to achieve the dual aim of advancing basic scientific understanding of Column IV semiconductor interfaces, on the one hand, and of addressing urgent technological needs for improved interface diagnostics in the silicon microelectronics industry, on the other.

In formulating the electromagnetics and information electronics components of this program, special emphasis was placed on developing a synergistic set of units. The common theme these units involve the development and application of advanced signal processing techniques to problems involving electromagnetic scattering, radar signal processing (superresolution direction finding, signal detection, and classification), increasing existing communication channel capacity, and modeling and mitigation of undesirable nonlinear effects in communication and other systems. The advanced signal processing techniques include, but are not limited to, wavelet transforms, superresolution techniques, higher-order statistics, adaptive frequency-domain Volterra filters, neural networks, and fast algorithm development.

Specifically, joint time-frequency signal processing has been exploited as a means of analyzing electromagnetic backscattered data from complex targets. Such techniques provide additional insight into the scattering phenomenology associated with such targets. High performance signal processing techniques have been developed to significantly increase the capabilities of wireless communication systems. A new parallel-adaptive predistorter to compensate nonlinearities introduced by high-power amplifiers in communication systems has been developed. The use of such predistorter-type linearizers allows the high-power amplifier to be operated a smaller back-off, and thus higher output power.

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Professor Dennis G. Deppe

Professor Michael C. Downer

Professor Hao Ling

Professor Christine M. Maziar

Professor Edward J. Powers

Professor Ben G. Streetman

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Ph.D. Dissertations

Eyink, Kurt, Ph.D. "Microstructural Changes in MBE Growth of LT-GaAs Observed by In-Situ Ellipsometry," May 1995 (Streetman)

Shaheed, M. Reaz, Ph.D., "Modeling and Simulation of Si- and SiGe-Base Bipolar Transistors Operating at a Wide Range of Temperatures," May 1995 (Maziar)

Srinivasan,, Anand, Ph.D., "Growth and Characterization of Low-Temperature Grown GaAs and Resonant Cavity Structures," May 1995 (Streetman)

Dadap, Jerry I., Ph.D., "Optical second-harmonic electro- and thermorefectance spectroscopy of Si(001)/SiO₂, H-Si(001), and Si(001)-2x1 interfaces by femtosecond pulses," August 1995 (Downer)

Eun, C.S., Ph.D., "Design and Comparison of Nonlinear Compensators," December 1995 (Powers)

Trintinalia,, L.C., Ph.D., "Time-frequency analysis of backscattering from inlet cavities embedded in Complex targets," August 1996 (Ling)

Deng, Hongyu, Ph.D., "Transverse Mode Confinement in Vertical-Cavity Surface-Emitting Lasers," The University of Texas at Austin, December 1996 (Deppe)

Rashed, Md. Mahbub Bin, Ph.D., "Monte Carlo Study of Transport in Strained Silicon and Silicon-Germanium Based Devices," December 1996 (Maziar)

Anselm, Klaus A., Ph.D., "High Performance Resonant-Cavity-Enhanced Photodiodes grown by Molecular Beam Epitaxy," May 1997 (Streetman)

Jeng, S.S., Ph.D., "Channel Propagation Study of SDMA Schemes for Wireless Communications," The University of Texas at Austin, June 1997 (Xu)

Hu, X.F., Ph.D., "Femtosecond second harmonic and ellipsometric spectroscopy of silicon-germanium interfaces," August 1997 (Downer)

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Hansen, L., Ph.D., "The Hypercube algorithm: A sequential algorithm for separating synchronous M-ASK or QAM co-channel signals," May 1998 (Xu)

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Kwan,W.M. H., Ph.D., "Parallel Implementation of a Fast Third-Order Volterra Digital Filter," August 1998 (Powers)

Yoo, H., Ph.D., "Quality of the Volterra Transfer Function Estimation," August 1998 (Powers)

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Filindras, A., M.S., "Scattering from conductor-backed dielectric slabs: simulation and time-frequency phenomenology interpretation," August 1995 (Ling)

Torlak, M., M.S., "Smart Antennas for CDMA Systems, Nov. 1995 (Xu)

Ozdemir, C., M.S., "Scattering from dielectric-coated wire: simulation and time-frequency phenomenology interpretation," December 1995 (Ling)

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Mehta, S.P., M.S., "Wavelet Based Higher-Order Time-Scale Analysis and its Applications," August 1996 (Powers)

K.V. Phanasalkar, K.Y., M.S., "Comparison of Neural Network Based Predistorters and Equalizers in the Presence of Noise," August 1996 (Powers)

Wang, Y., M.S., "Multimode parameter extraction for general multiconductor transmission line via FDTD method and signal processing techniques," August 1996 (Ling)

Zhu, J.-D., M.S., "Application of Nonlinear Signal Processing Techniques in Telecommunication Network Modeling," August 1996 (Powers)

Anderson, M.H., M.S., "Fourth harmonic spectroscopy of semiconductor surfaces," M.S., December 1996, (Downer)

Mathew, Nevin, M.S., "Linewidth of a Homogeneously Broadened Bad Cavity Laser," The University of Texas at Austin, December 1996 (Deppe)

Trump, C.E., M.S., "Femtosecond frequency domain interferometer for probing laser-induced phase transitions in silicon," December 1996 (Downer)

Baklenov, Oleg, M.S., "Growth of Quantum Dots by Molecular beam Epitaxy," May 1997 (Streetman)

Lenox, Chet, M.S., "The Use of the Native Oxide of Aluminum Gallium Arsenide in Optoelectronic Devices Grown by Molecular Beam Epitaxy," May 1997 (Streetman)

Büngener, R., M.S., "Si/Ge epitaxial growth surface monitoring by second harmonic generation," August 1998 (Downer)

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Kempf, R., M.S., "Second, third and fourth harmonic generation at Si(110) and Si(111) surfaces," August 1998 (Downer)

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